1981 HAMILTON AIR QUALITY

Ministry
of the
Environment
Ontario

Date Due

1981 HAMILTON AIR QUALITY

MINISTRY OF THE ENVIRONMENT
TECHNICAL SUPPORT SECTION
WEST CENTRAL REGION

JULY 1982

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SUMMARY

Air quality in Hamilton has improved significantly since 1970 in terms of long term averages for most monitored pollutants. The main concerns continue to be particulate matter, occasional odour problems and elevated pollutant levels during inversion conditions. Suspended particulate levels dropped most perceptively during 1972-75 period and this improvement is attributable to the control programs instituted by the major industries in conjunction with the Ministry of the Environment. Since 1975 though, levels have remained relatively stable and are still unsatisfactory in a part of the city, especially near the heavy industry. However, the majority of the city does generally experience acceptable levels of suspended particulates.

In 1981, levels of suspended particulates decreased by about 13% from 1980 levels. This improvement was widespread throughout the Region indicating that weather conditions or some other factors were responsible for the improvement.

Soiling index did not show the same improvement. Levels were relatively unchanged or slightly higher than in 1980.

Dustfall also remained unchanged and has remained at a constant level throughout the 1970's, above objectives in a large part of the city.

The air pollution index recorded three more elevated incidents in 1981 than in 1980 due to more frequent inversion conditions.

Levels of sulphur dioxide, carbon monoxide and oxides of nitrogen remained acceptable in 1981 with all objectives met except for three hours above the objective for nitrogen dioxide which were due to vehicle traffic.

Levels of total reduced sulphur increased slightly at the main station on Barton Street, probably due to the greater number of inversions in 1981. The North Park station on the Beach Strip remained unchanged and recorded levels similar to those found at Barton.

The average of ozone levels decreased marginally in 1981 and there were fewer hours above the objective than in 1980. Ozone, a secondary pollutant arising from photochemical reactions in the atmosphere is a regional problem and elevated levels above the objective have been recorded throughout Southern Ontario and the United States. Most of Southern Ontario's high levels seem to be caused by long range transport from the United States.

Fluoride emissions stem mostly from industrial sources as indicated by fluoridation rates, which continued to show elevated levels near the industrial area in 1981 and which showed large reductions in the industrial area during the Stelco strike. Based on past phytotoxicology studies, it is improbable that the fluoride levels were high enough to cause vegetation damage.

INTRODUCTION

The Air Management Program in Ontario is based on controlling man-made emissions to meet ambient air quality objectives, which in turn are based on known effects on health, quality of life or sensitive vegetation, whichever is most stringent. To achieve these objectives, sources of pollution are identified, their emissions evaluated and appropriate control measures are instituted. Ambient air monitoring is then used to verify that the controls have been successful. Monitors are mainly sited in areas suspected of experiencing higher levels of air pollution. If and when these areas achieve acceptable air quality, then other areas should also be acceptable.

Inventories of emissions from major pollution sources are maintained and can be used in mathematical modelling to predict pollutant concentrations at any given point in the atmosphere; however, more importantly, this inventory allows for an evaluation of the control programs and strategies through comparison of emissions to ambient air quality trends.

During August 1 to December 3, the Steel Company of Canada's Hilton Works was on strike. Since a detailed report of the strike's effect on local air quality has already been published, this report will only make occasional, cursory references to the findings. The strike report is available on request.

MONITORING NETWORK

The Ministry of the Environment operates a network of ambient air monitors throughout Hamilton as shown in Figure 1. Monitoring is most concentrated in the lower city, that is, the area below the Niagara Escarpment, and the network is centered on two major stations which monitor a variety of pollutants with mostly automated analyzers. The main station, known as 29025 - Barton/Sanford provides the data which forms the basis for the Hamilton Air Pollution Index (API). The other major station is on the Beach Strip and is known as 29008 - North Park, immediately adjacent to the Queen Elizabeth Way. The remainder of the network consists of numerous but mostly less sophisticated monitors. Most of the network has been in existence since at least 1970. Besides this regular network, special surveys are carried out occasionally in order to identify specific problems.

Meteorological data (wind speed and direction and temperature) are observed at station 29026, located on the sewage treatment plant grounds on Woodward Avenue. We consider this location to be more representative of local conditions than the Federal Government's Mount Hope Weather Station due to the complex meteorological patterns which sometimes prevail in Hamilton.

AIR POLLUTION INDEX

The Hamilton air pollution index (API) is used as a warning system to alert the public to elevated air pollution levels. It is derived from 24 hour average concentrations of sulphur dioxide and particulate matter as measured at the Barton/Sanford Station. The combination of these two pollutants has been shown to be at least indicative of detrimental human health effects. No action is taken for readings up to 31. At 32, known as the advisory level, and with a forecast of unfavourable dispersion conditions, major point source emitters are notified and asked to voluntarily curtail certain operations. At an API of 50, cutbacks by these sources become mandatory. These levels are set with a considerable safety margin before health effects should take place.

The API station is located at the interface between the heavy industrial and residential areas of the city and about half-way between downtown and the integrated steel mills and is directly downwind of the industrial area during times of poorest atmospheric dispersion. Due to differences in station locations in relation to local sources, inter-city API comparisons are rather tenuous and therefore, caution must be exercised in their interpretation.

During 1981, there were eight instances of the API reaching or exceeding 32 as listed in Table 1 and these were related to three types of meteorological regimes.

In two cases (June 2, June 13), prolonged and widespread northeast winds of light to moderate speed predominated. The time above 32 was short as wind shifts cleared the air each time.

Four of the incidents were related to inversions due to the classical lake breeze phenomenon (Feb. 19-20, May 5, June 3 and July 2-3) in which cool lake air flowed very lightly into the city beneath a warm flow of southerly winds.

The final two incidents were the most severe and were related to subsidence inversions caused by the stagnation of high pressure cells (Oct. 14-15 and Nov. 14-15) with the inversions being intensified by the

lake breeze effect. Winds were very light and elevated pollution levels were widespread throughout Southern Ontario and significantly, both occurred during the Stelco strike.

PARTICULATES

There are three methods for the measurement of particles, each method relating to a different size range. Dustfall jars measure heavy material, generally greater than 10 microns in diameter. High volume samplers measure suspended particulates ranging in size from submicron to 50 microns and co-efficient of haze tape samplers measure mostly fine material - from submicron to about 10 microns.

The ambient air quality objectives for suspended particulate and soiling are based on health effects when occurring in combination with sulphur dioxide. As mentioned previously, this combination was proven to be indicative but not necessarily causative of such health effects. The dustfall objectives are based on nuisance effects.

Total Suspended Particulates

A high volume sampler draws a known volume of air through a pre-weighed filter for a 24 hour period (midnight to midnight). The exposed filter is weighed and the difference in conjunction with the known amount of air flow is expressed as concentration in micrograms per cubic meter. At two locations in Hamilton, these devices operate daily. At all other locations, they run on a once every six day cycle.

The Ministry operated 14 hi-vol stations in 1981 and each showed reductions from 1980 (Table 2a). The average reduction was 13%. Similar decreases were observed throughout the West Central Region, indicating that weather or other factors were the cause of the improvement. The Stelco strike played a small part as noted in a previous report[1]; however, while a small decrease of 8% did occur over the Aug. - Nov. strike period compared to the same months in 1980, the decrease during the other 8 months from 1980 to 1981, was even larger - 15%. These results are tabulated in Table 2d.

1. Ontario Ministry of the Environment, Hamilton Air Quality During the Stelco Strike, August - November, 1981.

The hi-vol filters were analyzed for seven metals, sulphates and nitrates. The data is tabulated in Table 2c.

Concentrations of nickel, cadmium, lead and vanadium showed very low concentrations which did not vary appreciably throughout the city indicating that these were background levels. The 24 hour criteria for these metals were easily met.

Concentrations of chromium and manganese were somewhat higher and showed a gradient with distance from the industrial area, however, the highest levels were well below acceptable levels.

Iron concentrations were high, and also showed a gradient with distance from the industrial area where concentrations were generally well above acceptable levels.

The sulphate/nitrate components comprised a large portion of the measured particulate matter. Both of these constituents are the products of atmospheric reactions of sulphur dioxide and oxides of nitrogen. These gases are largely by-products of major high temperature fuel combustion sources and they, together with the sulphate/nitrate products, can travel hundreds of miles from the source. The concentrations in Hamilton are generally uniform with only slightly higher levels found in the industrial area, indicating a small contribution from local industries. However, most of the city shows levels similar to other areas in the province including rural areas, indicating that much of this material is imported into the city via long range transport from distant sources. The sulphate component is known to be a factor in reduced visibility and is often responsible for the widespread haze observed in Hamilton during southerly winds.

McMaster University also continued hi-vol sampling as part of their study on the health effects of air pollution. Their sampling coincided with the Ministry sampling schedule, making their network of 14 hi-vols a useful supplement to ours. The samplers are mostly situated in residential areas on the mountain and far ends of the city and most recorded very low concentrations, generally within objectives (Table 2b). One monitor at Woodward/Brampton showed a severe deterioration in the yearly mean,

rising well above the objective. However, this can be attributed to construction activities from September to December at the sewage treatment plant which influenced the readings substantially. The dustfall jar at this site was also affected.

The large dual network makes it possible to draw a contour map of suspended particulate concentrations, given in Figure 2. It can be seen that the majority of the city meets the yearly objective of 60 ug/m^3. The area within this contour exceeding the objective comprises roughly 30% of the area within city boundaries. Concentrations are only elevated close to the industrial area plus in a small pocket of light manufacturing near Main Street and Highway 403.

The effect of urban activity on suspended particulate concentrations is illustrated by three monitors in the downtown area. All three are in the same general area with respect to the industrial area, but show widely different results. The hi-vol on the roof of City Hall (29007) approximately 200 feet above ground, had a geometric mean of 57 ug/m^3 while only a short distances away near the intersection of James and Hunter (29001), the mean was 63 ug/m^3. This monitor on the roof of the Regional Health Unit is only 30 feet above ground. The difference in concentration between the two stations is probably accounted for by proximity to road traffic. Another short distance away is the Aberdeen monitor whose mean was only 41 ug/m^3, well below the objective. This hi-vol is in a residential area set off from major roadways and the heavy activity of the business district.

A similar observation is noted in the east end of the city. The hi-vol at the Centennial Parkway location showed a mean of 58 ug/m^3 while in a residential area on Pottruff Road, the mean was only 40 ug/m^3. Again, the difference would seem related to road traffic.

The same seems to apply at the North Park station (29008) on the Beach Strip which is located immediately adjacent to the Q.E.W., a major highway. Highway emissions were suspected of having a large influence on several of the parameters measured there, especially suspended particulates. Consequently in 1981, a special hi-vol was operated at Bell Cairn School, a short distance away, but removed from the direct

influence of the highway (station 29092). The data measured at the school showed significantly lower concentrations than at North Park where the yearly mean was 72 ug/m^3 compared to only 60 ug/m^3 at the school. Wind direction studies indicated that a 10 - 12 ug/m^3 difference was consistent for all wind directions, not just winds from the highway. It is suspected that the highway continuously affects the North Park station regardless of wind direction.

Soiling Index (Co-efficient of Haze)

Co-efficient of haze tape samplers operate continuously and can determine hourly or two-hour average soiling values. Air is drawn through a filter paper and the optical density of the soiled spot is measured by light transmittance. Unfortunately, the one-hour telemetered instruments have been demonstrated to yield values at least 25% higher than the two-hour instrument for equal samples of air, and hence, the two types of measurement are not directly comparable. Due to this unresolved difference, the two-hour data are presented separately from the one-hour data.

The main stations on Barton Street and North Park both employ one-hour instruments (Table 3a). North Park again showed a high average well above the yearly objective, similar to 1980 with 76 days above the daily objective. However, as demonstrated by the Bell Cairn hi-vol survey, the Q.E.W. significantly affects particulate measurements at North Park. The soiling index would be similarly affected. Barton Street showed levels similar to 1980, slightly above the yearly objective, with 24 days above the daily objective.

Seven other stations in the lower city employ two-hour instruments, and all recorded low averages well below the yearly criterion (Table 3b). A new monitor was employed in the heart of the industrial area at Burlington/ Leeds (29011) where hi-vol sampler observations are usually quite high. It showed a very low mean and only one excessive daily average. These results were undoubtedly related to the lower readings provided by the 2-hour measurement as discussed above.

Dustfall

Dustfall is that material which settles out of the atmosphere by gravity, and is collected in plastic containers during a 30 day exposure time. The collected material is weighed and expressed as a deposition rate of grams/square meter/30 days. The significance of observations is restricted to relatively local areas.

Dustfall levels in 1980 (Table 4) remained similar to those of previous years. Figure 3 depicts dustfall isopleths, and shows that a portion of the lower city and the Beach Strip near the industrial area was encompassed by the 9.0 grams/m^2/30 days contour which represents twice our objective. Conditions in this area, for the most part were quite poor, however, the area is relatively small - only about 15 square kilometers. Only one station on the mountain recorded a mean below the yearly objective of 4.5 grams. The contour of this concentration showed that it encompasses about half of the city. Dustfall levels throughout the city have remained virtually unchanged throughout the 1970's; a puzzling observation considering the considerable reductions in industrial process emissions and the correspondingly large reductions in soiling index and suspended particulate concentrations noted in Figure 4. Fugitive dust sources such as uncontrolled stock piles, excavation and construction, vehicular emissions, road dust, open lots susceptible to wind erosion, etc. may be important in explaining this observation.

Two of the stations were affected by construction activities in the immediate vicinity of the monitors. At Dofasco, the construction of a new hot strip mill which began in the spring continued all year and severely affected station 29010. Similarly, construction activities at the sewage treatment plant on Woodward Avenue from September to the end of the year significantly affected Station 29026.

SULPHUR DIOXIDE

Most sulphur dioxide (SO_2) emissions in Hamilton, as detailed by the emissions inventory, stem from industrial sources. Only a small portion is accounted for by fuel burning in domestic space heating. The Barton/Sanford and North Park stations monitor SO_2 continuously and data is summarized in Table 5.

Sulphur dioxide trends from the two stations since 1970 are illustrated in Figure 5. In 1981, as in the past several years, the concentrations were acceptable, within the yearly objective and there were no readings above the hourly or daily objectives. These objectives are based on vegetation damage; a more stringent limitation than human health effects.

TOTAL REDUCED SULPHUR

This pollutant was formerly identified as hydrogen sulphide (H_2S). However, since the analyzer also reacts to other sulphur compounds, the data is now referred to as total reduced sulphur. The objective for hydrogen sulphide may still be applied to the observed values and is based on the odour threshold level. Both Barton/Sanford and North Park monitor continuously and the data are summarized in Table 6.

The major sources of hydrogen sulphide and related sulphur compounds are the steel industry's coke ovens, certain slag reclamation processes and under upset conditions, a local manufacturer of carbon black. Another potential but rather minor source is Windermere Basin. Sulphur bearing organic sediments from Red Hill Creek and sewage overflow from the sewage treatment plant may during the spring, under certain adverse conditions, decompose and produce hydrogen sulphide. The sewage treatment plant itself is another minor source, but only during certain upset conditions when similar undesirable decompositions of sewage can occur.

Yearly trends for the two stations are illustrated in Figure 6. In 1981, H_2S concentrations at Barton were slightly higher than in 1980 with 46 exceedences of the hourly objective. The change was probably related to more frequent inversion conditions in 1981 as characterized by more frequent elevated API incidents.

Concentrations at North Park remained similar to 1980 with 35 exceedences of the hourly H_2S criterion.

The incidents of elevated concentrations at the two stations occurred separately and under different circumstances. The Barton incidents usually occurred during very light northeast winds, most often during

inversion conditions in the May - July period. The North Park incidents occurred during southwesterly winds with variable wind speeds and occurred randomly throughout the year.

CARBON MONOXIDE

The major source of carbon monoxide emissions is the automobile. However, in Hamilton there are also some contributions from industry. Due probably mainly to automotive emission controls, the levels measured at Barton Street (Table 7) decreased greatly over the 1970-81 period (Figure 7). In 1981, the levels were similar to the previous few years and were well below the objectives which are based on health effects.

OXIDES OF NITROGEN

The primary source of oxides of nitrogen are high temperature combustion sources including the automobile. The most abundant oxides are nitric oxide (NO) and nitrogen dioxide (NO_2), and they are monitored continuously at both Barton/Sanford and North Park. At each station, a single instrument makes measurements of NO, NO_2 and total nitrogen oxides. Nitric oxide is measured directly, and the total oxides are measured by internally coverting all other nitrogen oxides to nitric oxide. The instrument then determines nitrogen dioxide to be the difference between the first two measurements.

Of the three reported pollutants, objectives exist only for nitrogen dioxide and these are based on odour threshold levels and health effects.

Data for oxides of nitrogen are given in Tables 8 - 10, and yearly trends since 1975 are illustrated in Figures 10 - 12. The nitrogen dioxide hourly objective was exceeded three times in 1981, all at North Park in November and during rush hours. The higher concentrations were probably due to Q.E.W traffic. The daily objective was not exceeded. The trend to decreasing levels since 1977 ended in 1981 when levels were similar to 1980.

Similar to previous years, NO_2 levels were comparable at the two stations, but NO levels were about three times as high at North Park than at Barton. This is probably explained by North Park's close proximity to the QEW. Most vehicular emissions of oxides of nitrogen consist of NO which later is oxidized to NO_2 in the atmosphere. Under normal circumstances the North Park station probably monitors the NO before this conversion can fully take place.

Oxides of nitrogen are an important factor in the photochemical production of ozone which will be discussed later in this report.

OZONE

Oxidants are mainly a product of photochemical reactions involving oxides of nitrogen, hydrocarbons and sunlight. Ozone accounts for most of the oxidants produced. The sources of the precursor pollutants are mainly industrial and automotive.

Ozone is known to be associated with many respiratory problems, and at elevated concentrations, people can experience adverse health effects. Ozone is also injurious to different types of vegetation including certain tobacco and tomato crops. The one-hour objective for ozone (.08 ppm) is based on both health and vegetation effects.

Ozone concentrations follow very definite annual and daily trends. Highest levels occur during the summer (May - September), and the daily maximums usually occur during mid-afternoon. Both patterns are directly related to the amount and intensity of sunlight.

Ozone is measured at the Barton Street station, and data is summarized in Table 11 while yearly trends are illustrated in Figure 8.

The 1981 average showed a slight decrease with fewer exceedences of the hourly objective than in 1980 - only 15 in June to August. These higher concentrations were widespread, occurring concurrently throughtout Southern Ontario during periods of southerly or southwesterly winds which implies their origin to be in the United States.

Ozone, hydrocarbons and oxides of nitrogen can be transported over great distances and can be augmented by local sources. However, Hamilton and other major urban areas usually experience lower ozone concentration than their more rural surroundings during peak occurrences. In fact, the concentrations in Hamilton are among the lowest recorded in Southern Ontario, probably due to the numerous high temperature combustion sources which produce higher levels of nitric oxide, a scavenger of ozone. Nonetheless, ozone and other oxidants remain a problem which, due to the complexity of their formation and the long range transport phenomenon, will have to be resolved on a regional rather than local scale.

FLUORIDATION

This measurement is a crude assessment used to determine relative quantities of various fluoride compounds in the ambient air. A lime coated paper is exposed to the atmosphere for approximately 30 days and is then chemically analyzed for fluoride. The fluoride objectives are based on vegetation damage and for this reason, the objective is more stringent during the growing season. For the period of April 15 to October 15, it is 40 micrograms/100 square centimeters/30 days while for the remainder of the year it is 80.

In Hamilton, the major fluoride sources are the basic oxygen furnaces used by the major steel industries which require fluorspar as a fluxing agent. In addition to these process emissions, there are other minor sources such as coal burning since coal contains trace amounts of fluoride.

Data for 1981 is summarized in Table 12 and the yearly trend since 1980 is illustrated in Figure 9.

The trend graph shows that levels have remained relatively stable since 1974 following large reductions in concentrations which began in 1971.

In 1981, except for the Stelco strike period, consistently elevated concentrations continued to be observed on the Beach Strip (29008 and 29058) and at Burlington/Gage (29059) near the main fluoride sources.

Most of the rest of the stations showed only occasional and marginal exceedences of the objectives. Based on past vegetation studies, it is unlikely that even the highest concentrations affected local plant life. As noted in a previous report, fluoride concentrations reduced considerably during the Stelco strike in the worst areas, to just marginally above objectives.

DISCUSSION

Except for an unaccounted for decrease in suspended particulates, concentrations of most pollutants remained unchanged from 1980 levels. The city remains very susceptible to short periods of elevated pollutant levels during inversion conditions, usually in the spring or fall. Odour problems become most apparent under these conditions.

Except for these occasional odours, most gaseous pollutants are under control. However, dust particles remain elevated in the vicinity of the industrial area. Industrial emissions were reduced significantly from 1970 to 1975 and moderately since then. The finer measured particles, as characterized by suspended particulate and soiling index, show a similar trend. In contrast, the heavier, settleable material known as dustfall, quite suprisingly, has shown no improvement at all since 1970. This seems to indicate that apart from the remaining process emissions, other pollution sources on which no emphasis has yet been placed, will require control. These sources can be both industrial and non-industrial in nature, such as blowoff from unpaved areas, excavation, construction, demolition, road traffic, uncontrolled stock piles and other non-stack industrial emissions.

Results of a study by independent researchers indicates that the contributions from industrial sources to long term average particulate concentrations are relatively minor and other (fugitive) sources are the major causes.

In 1980, further control orders were issued to the major steel industries. Implementation of the orders will extend into 1985. Emphasis was placed on further reducing emissions from coke ovens, blast furnaces and steel making furnaces through the upgrading and repair of some of the current facilities.

RESEARCH STUDIES

A study by the Ontario Research Foundation funded by the Federal and Provincial Governments as well as industry, has been completed. It was aimed at identifying the type and origin of dust particles in Hamilton's air, including the effect of road dust and its re-entrainment by wind and traffic. The basis for this study was the fact that during recent years, improvements in air quality have not been proportional to abatement efforts by government and industry. It appears that there is a limit to further air quality improvements which can be achieved through control of traditional sources, and that abatement measures which could be undertaken are becoming increasingly costly and decreasingly efficient. The study revealed that the contributions from industrial point sources to long term particulate concentrations in the downtown area are relatively minor and that other sources including road traffic were the main contributors. The study did not address the industrial contribution during inversion conditions when it would likely be more significant.

Also, McMaster University is carrying out a three year provincially and federally funded study which will attempt to determine by extensive breathing tests, the respiratory health of 3,800 Hamilton school children, and will relate these data to air quality measurements. The project will also inter-relate other factors, such as indoor environment, which may affect the children's respiratory health. Results of the study will provide evidence in establishing sound criteria, standards and indices for ambient air quality based on actual health effects.

During 1981, the Ministry of Health initiated a special study, to investigate the possible health effects on residents living near the Upper Ottawa Street Landfill site. The study will include ambient air assessment for hazardous substances.

ACKNOWLEDGMENT

We would like to thank Mr. Stephen A. Toplack of the Urban Air Environment Group at McMaster University for providing their suspended particulate data.

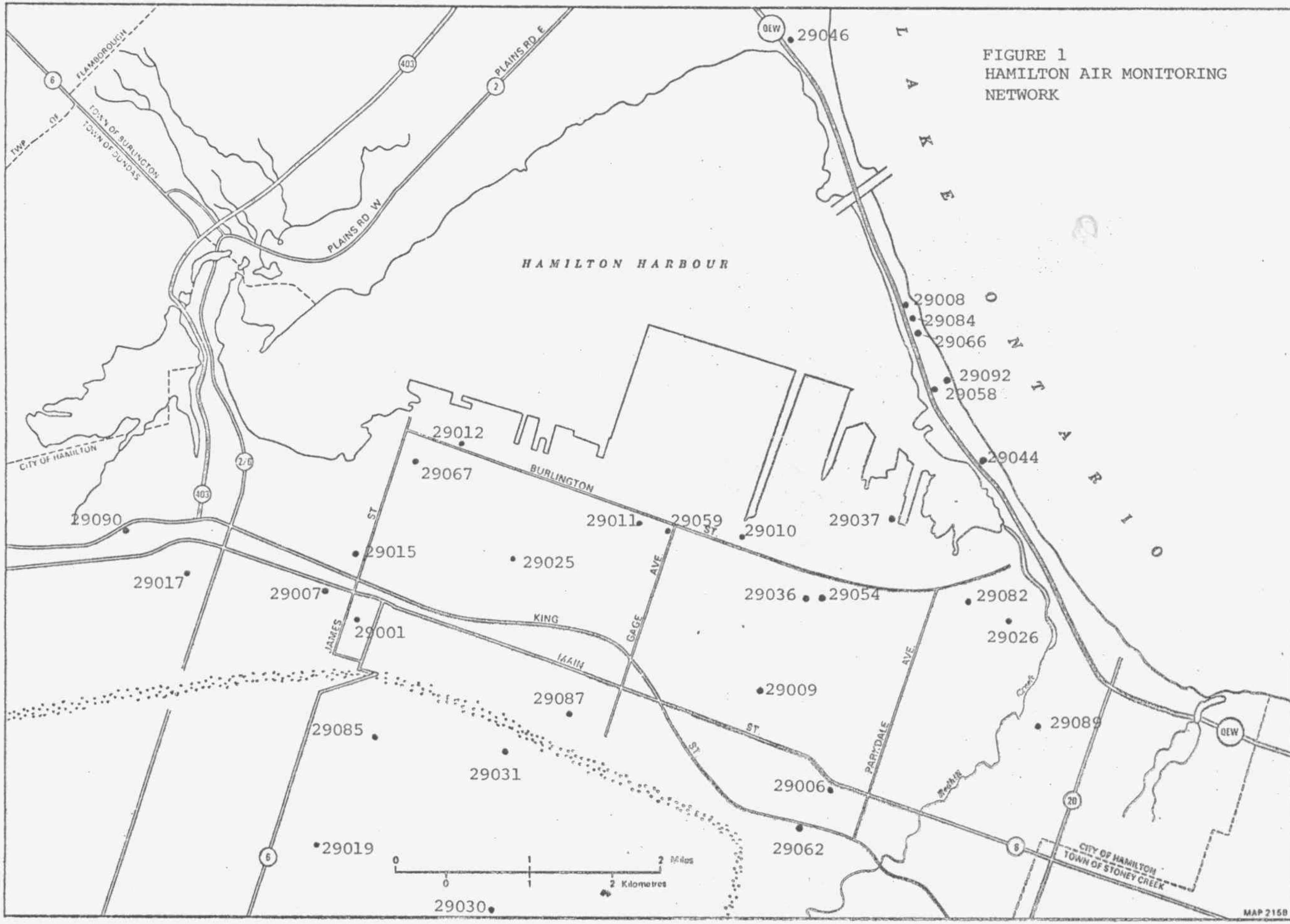


FIGURE 1
HAMILTON AIR MONITORING
NETWORK
HAMILTON HARBOUR
LAKE ONTARIO
29046
29008
29084
29066
29092
29058
29044
29037
29012
29067
29011
29059
29010
29090
29015
29025
29017
29007
29036
29054
29082
29026
29001
29009
29087
29089
29085
29031
29006
29062
29019
29030
BURLINGTON ST.
KING
MAIN ST.
GAGE AVE.
JAMES ST
PARKDALE AVE.
PLAINS RD. E
PLAINS RD. W
CITY OF HAMILTON
TOWN OF STONEY CREEK
TOWN OF BURLINGTON
TOWN OF DUNDAS
QEW
403
MAP 2158

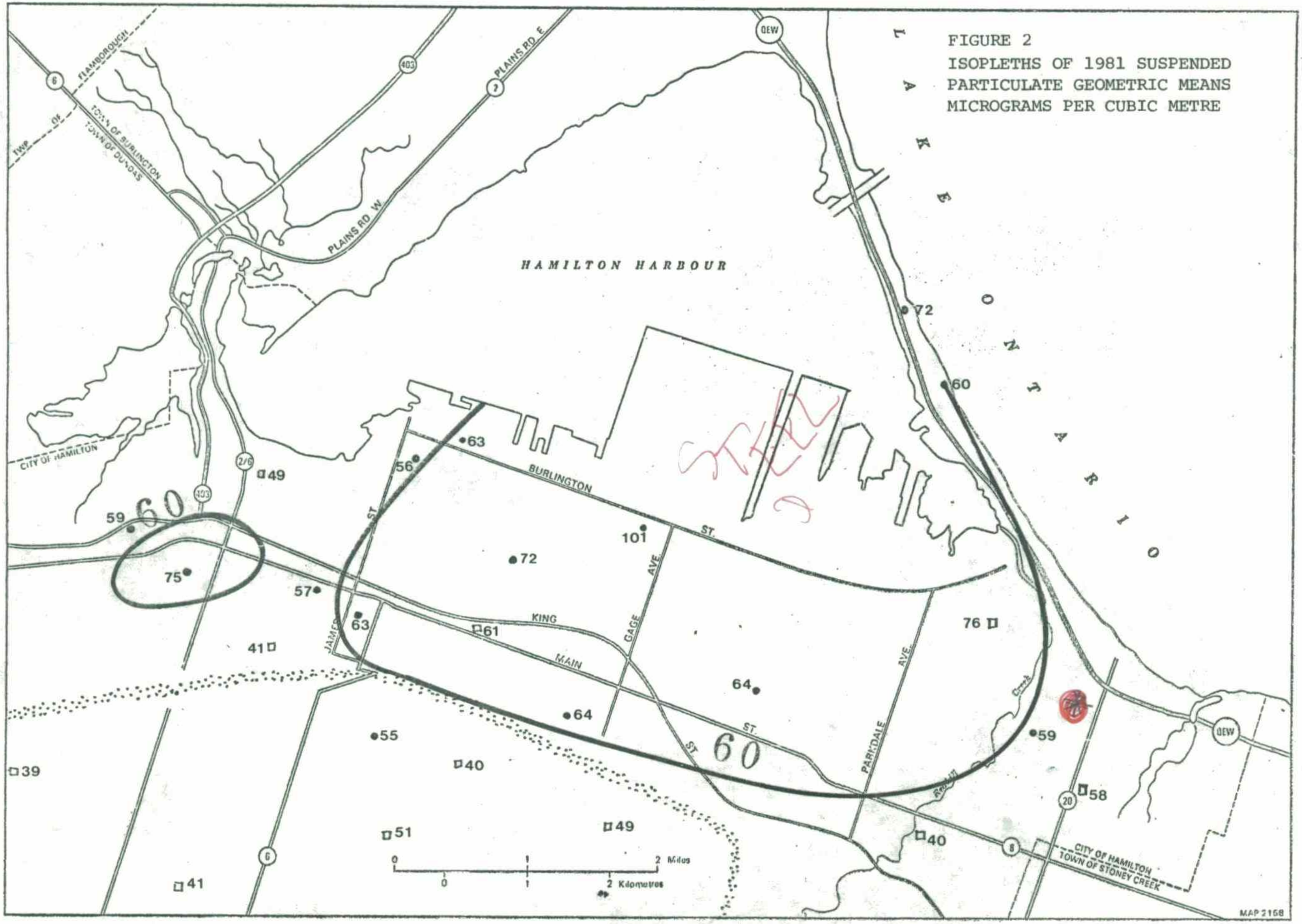


FIGURE 2
ISOPLETHS OF 1981 SUSPENDED PARTICULATE GEOMETRIC MEANS MICROGRAMS PER CUBIC METRE

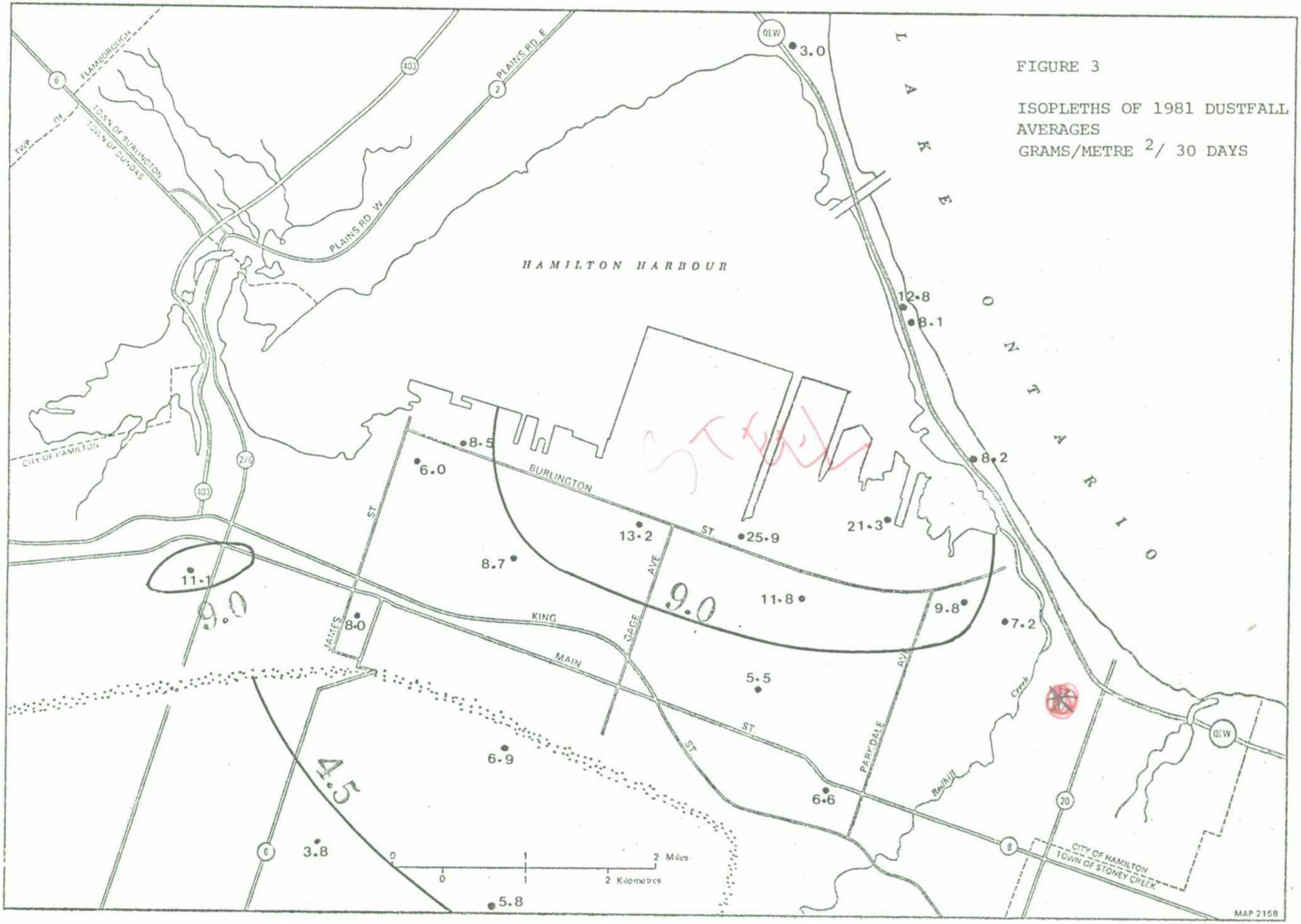
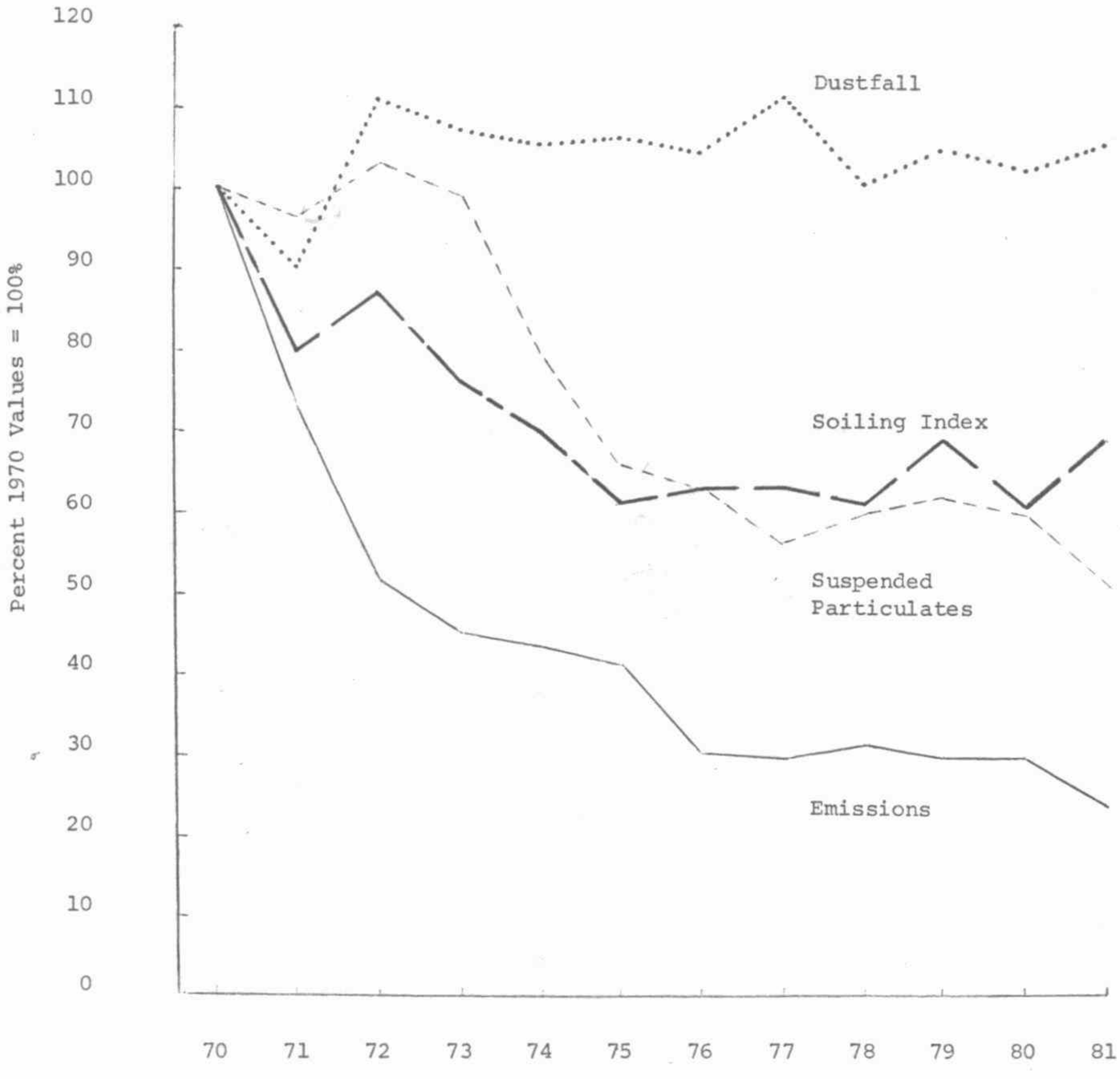


FIGURE 3

ISOPLETHS OF 1981 DUSTFALL AVERAGES GRAMS/METRE ^{2}/ 30 DAYS

FIGURE 4

Particulate Trends vs Estimated Emissions



Suspended Particulate (7 stations)	131	127	135	130	104	86	83	73	77	81	77	67
						ug/m^3						
Dustfall (17 stations)	9.4	8.5	10.4	10.1	9.9	10.0	9.8	10.4	9.4	9.8	9.6	9.9
						g/m^2/30 days						
Soiling Index (7 stations)	.54	.43	.47	.41	.38	.33	.34	.34	.33	.37	.33	.37
						COH's/1000 ft						
Institutional & Industrial Emissions	56	41	29	25	24	23	17	16	17.5	16	16	13
						Million lbs/year						

Yearly Trends of Pollutants

FIGURE 5

Sulphur Dioxide

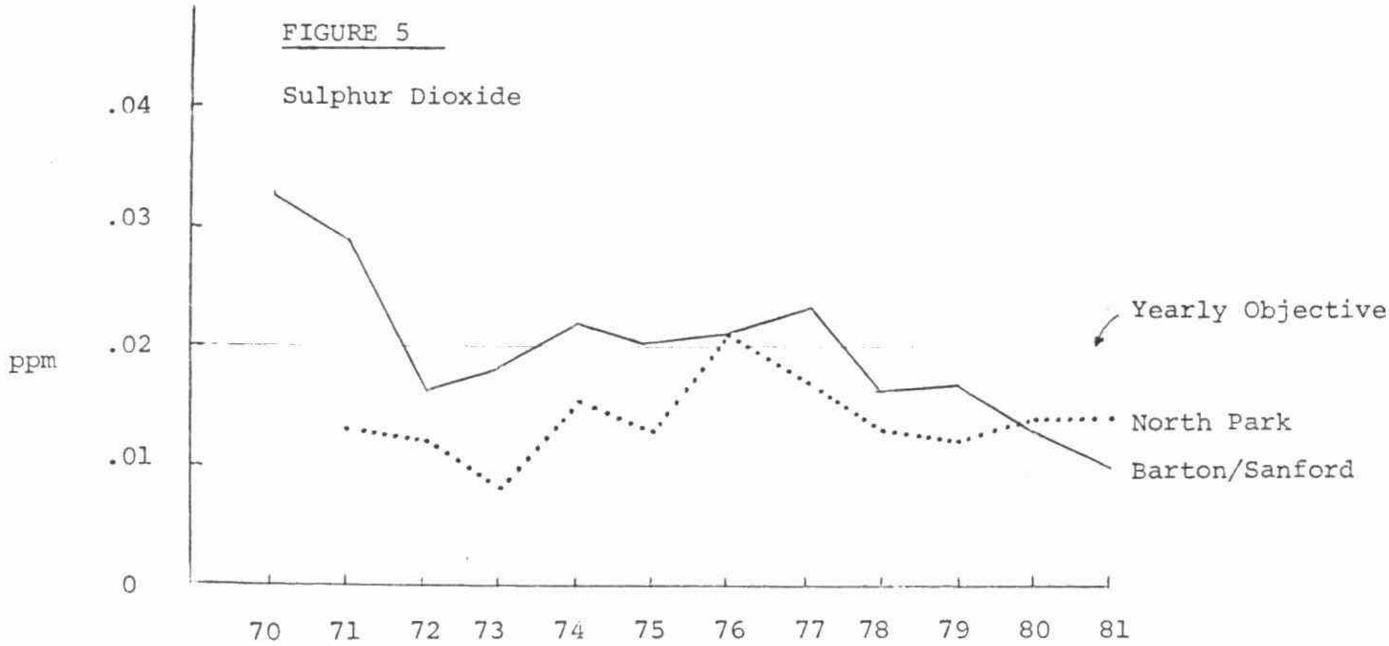
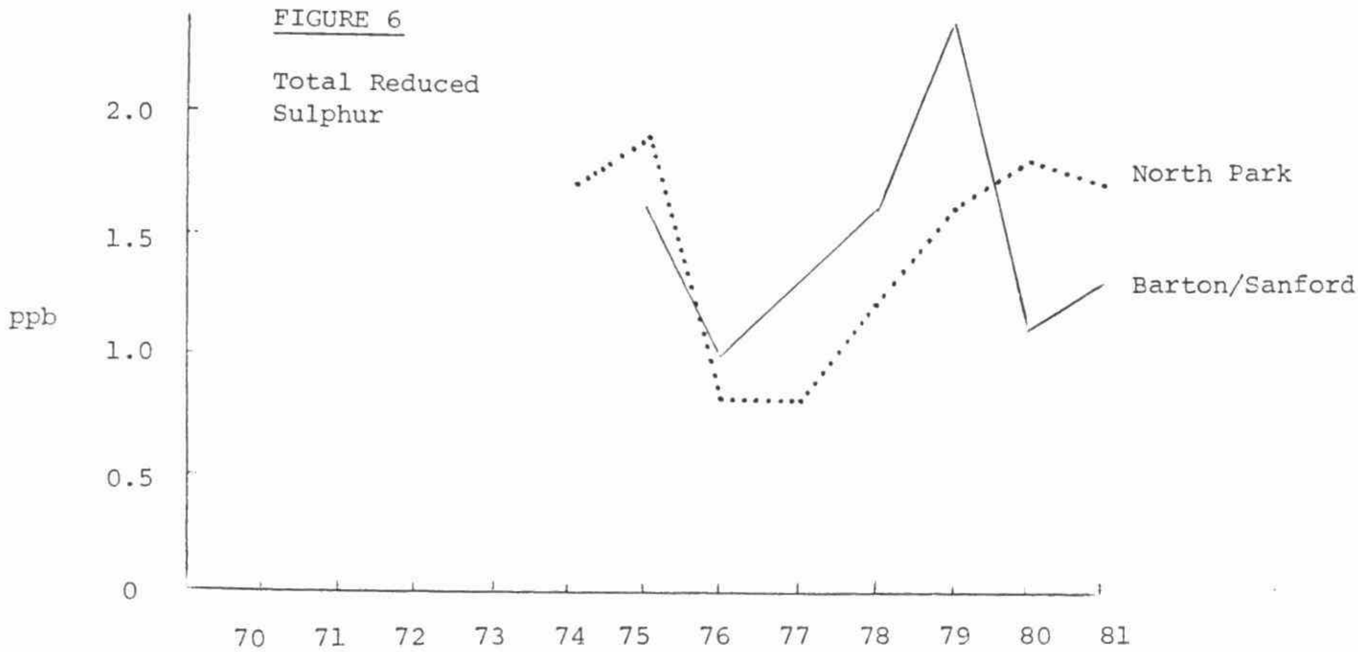


FIGURE 6

Total Reduced Sulphur



Yearly Trends of Pollutants

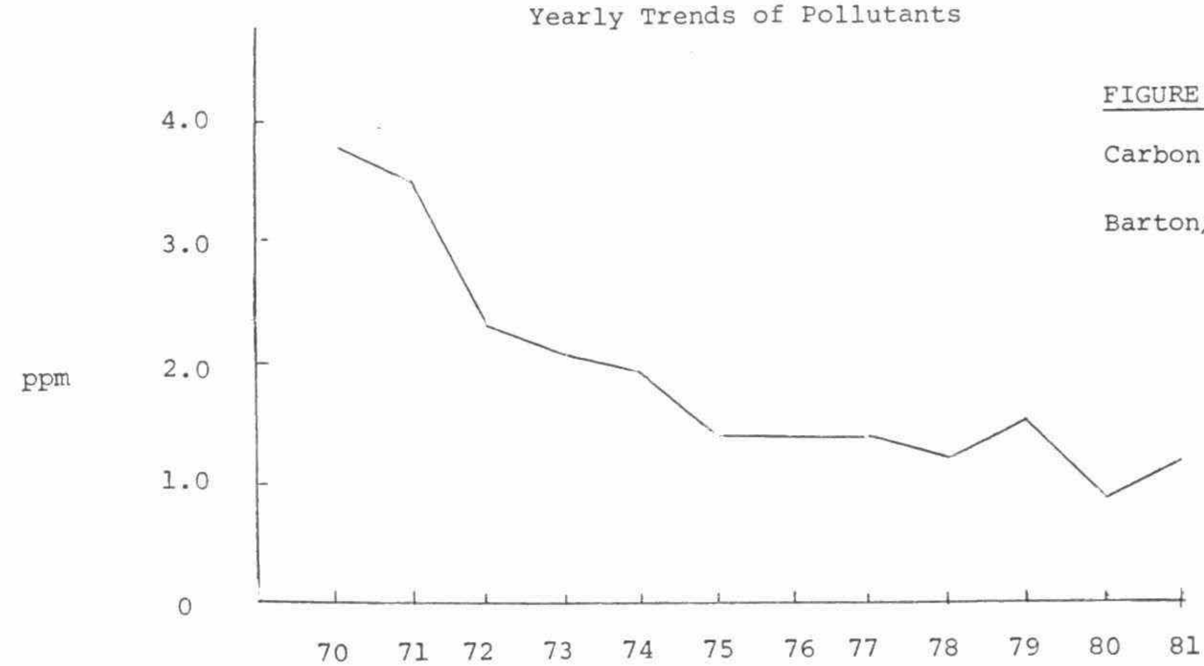


FIGURE 7

Carbon Monoxide

Barton/Sanford

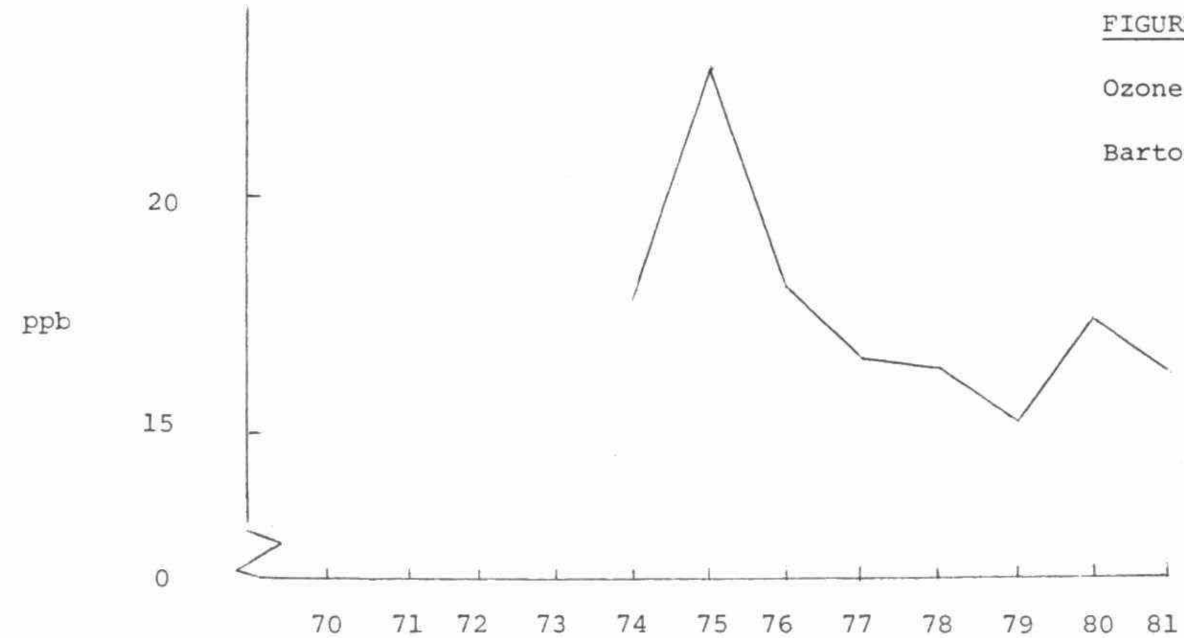


FIGURE 8

Ozone

Barton/Sanford

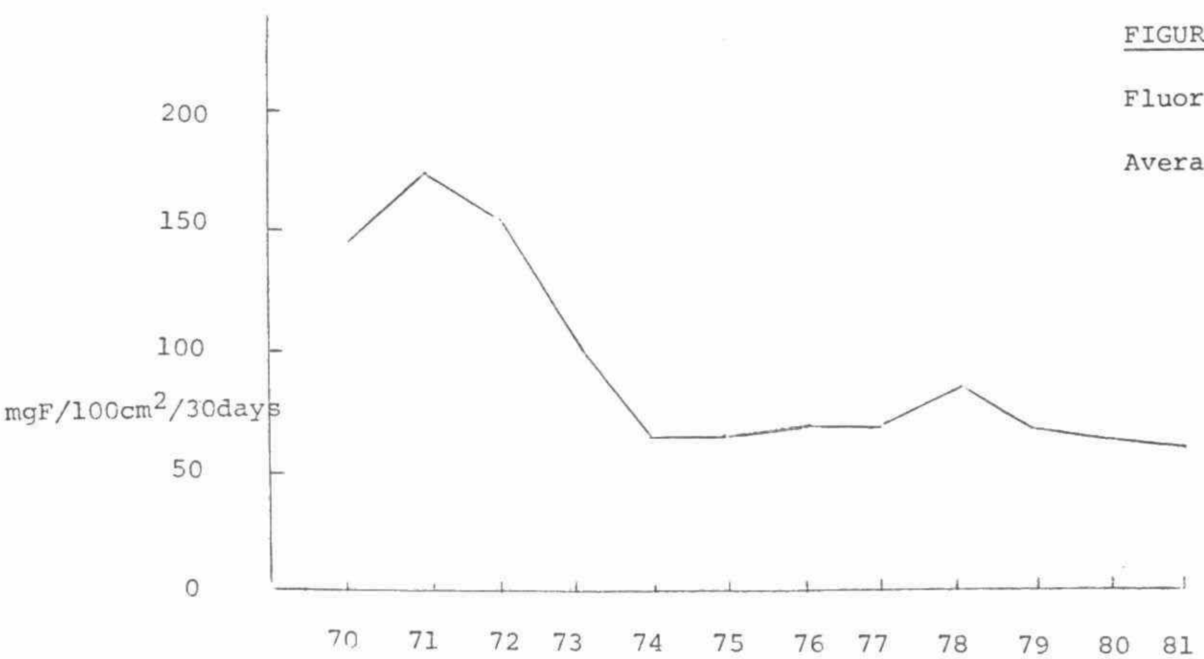


FIGURE 9

Fluoridation Rate

Average - 11 Stations

Yearly Trends of Pollutants

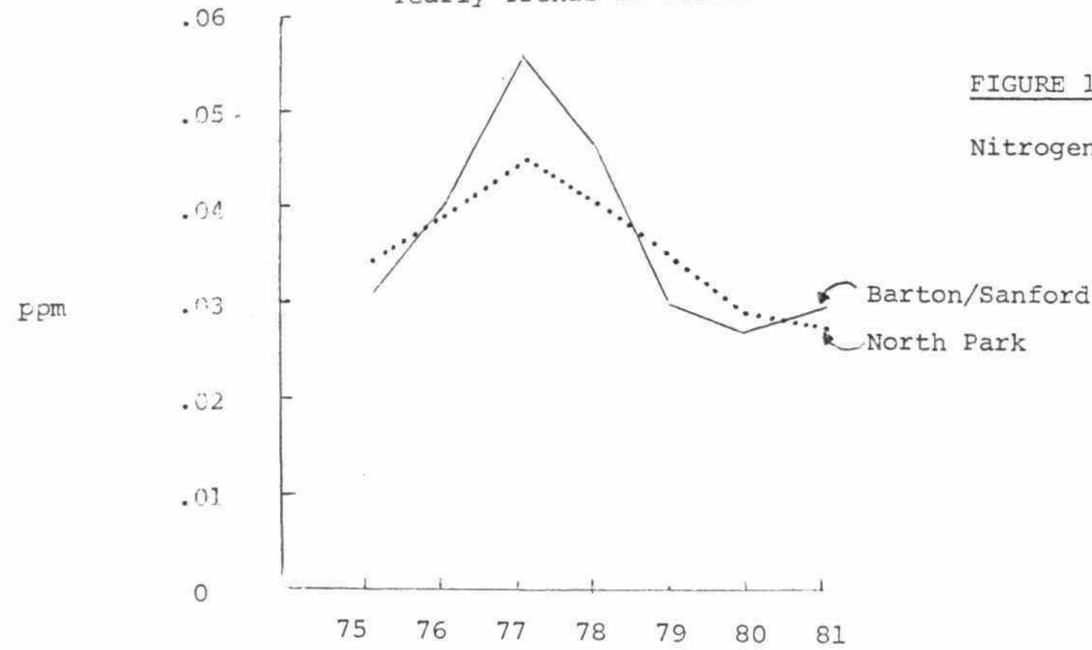


FIGURE 10

Nitrogen Dioxide

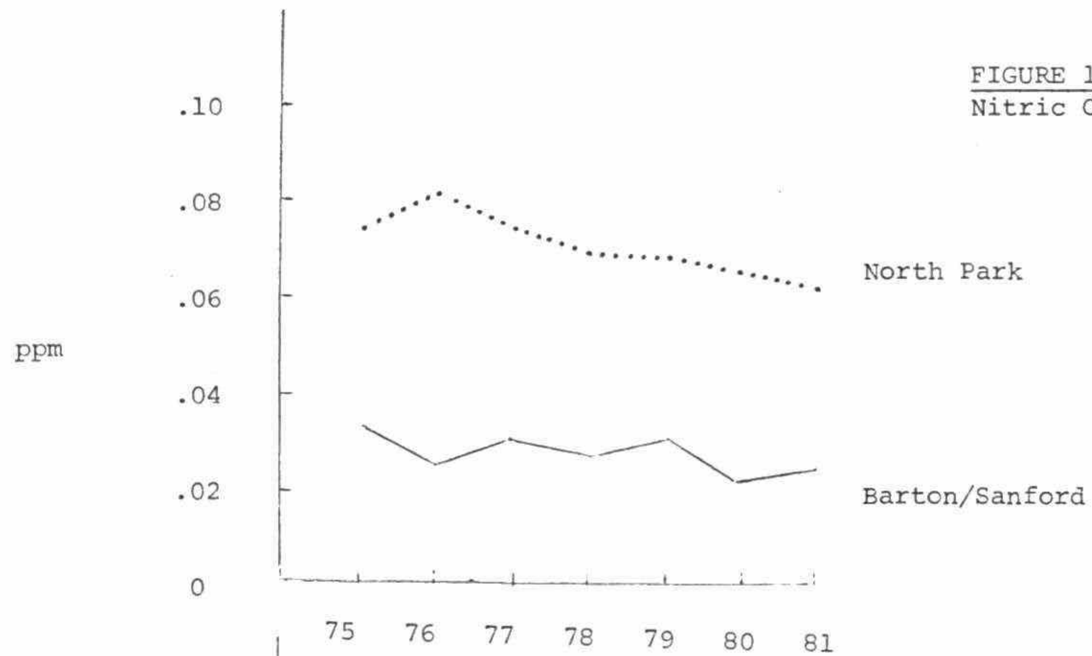


FIGURE 11
Nitric Oxide

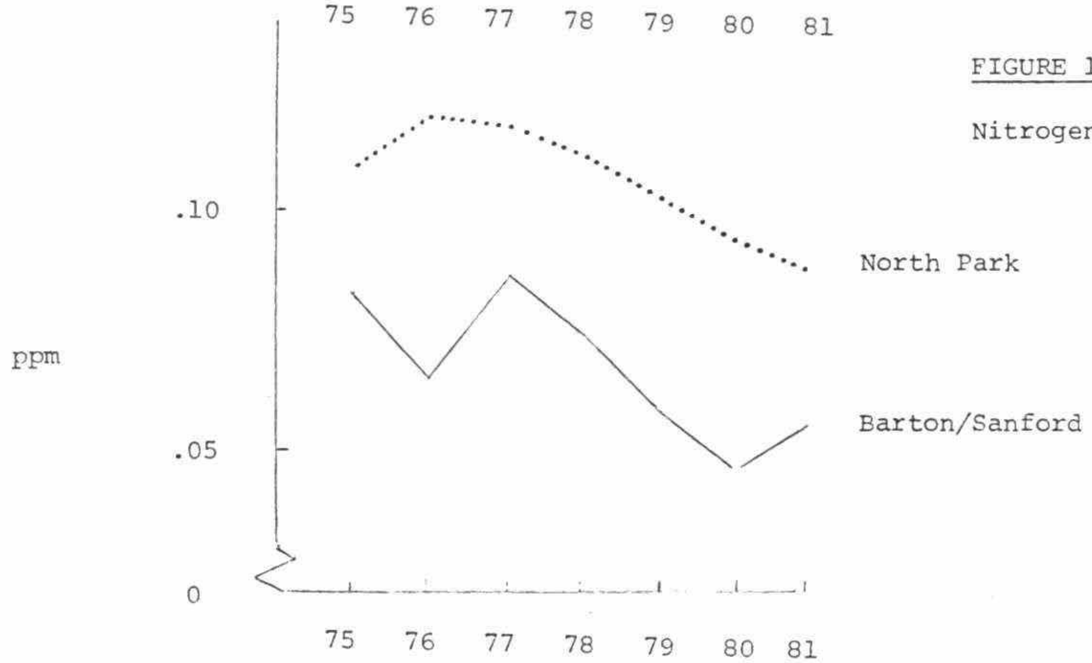


FIGURE 12

Nitrogen Oxides

TABLE I

AIR POLLUTION INDEX - 1981

OCCASIONS WHEN 32 OR ABOVE

	Date	Maximum	No. of Hours 32
1.	February 19-20	32	13
2.	May 5	34	9
3.	June 2	32	5
4.	June 3	33	5
5.	June 13	32	6
6.	July 2 -3	34	18
7.	Oct. 14 - 15	34	19
8.	Nov. 14 - 15	38	43

TABLE 2a

SUSPENDED PARTICULATES - 1981

UNITS - MICROGRAMS PER CUBIC METER

ONTARIO OBJECTIVES: 24-hour - 120
1-year Geo. Mean - 60

	No. of Samples	Geometric Mean 1981	1980	1979	Maximum	% of Samples Above 120
29001 - Hughson/Hunter	59	63	71	78	222	15
29007 - City Hall	56	57	59	60	229	9
29008 - North Park	334	72	95	96	302	19
29009 - Kenilworth	56	64	67	69	183	9
29011 - Burlington-Leeds	57	101	124	120	377	33
29012 - Burlington-Wellington	55	63	73	76	225	5
29017 - Chatham-Frid	57	75	84	91	340	12
29025 - Barton-Sanford	317	72	88	100	330	14
29067 - 450 Hughson St. N.	57	56	65	62	158	7
29085 - Mountain Police Station	55	55	56	61^{9}	195	5
29087 - Cumberland	58	64	65	73^{9}	203	9
29089 - Barton/Nash	48	59	70^{9}	-	144	2
29090 - Westdale Library	58	59	67^{5}	-	199	7
29092 - Bell Cairn School, Beach Blvd.	51	60	-	-	158	16

Exponents refer to number of months of sampling (when less than 12)

TABLE 2b

McMASTER UNIVERSITY SAMPLING - 1981

SUSPENDED PARTICULATES

MICROGRAMS PER CUBIC METER

ONTARIO OBJECTIVES: 24-hour average - 120
1-year Geo. Mean - 60

LOCATION	No. of Samples	Geometric Mean 1981	1980	1979	Maximum	% of Samples Over 120
San Diego Court	58	39	35	47	161	3
Upper Ottawa/Mohawk	56	37	36	44	110	0
Aberdeen/Undermount	54	41	45	51	147	2
Whitney/Rifle Range	58	43	44	55	171	3
Pottruff/Queenston	57	40	39	52	100	0
McElroy/Upper Wellington	55	51	43	55	140	5
Queensdale/Green Meadow	48	49	43	-	105	0
Upper Wentworth/ Queensdale	40	40	47	-	125	2
Main/Wentworth	53	61	62	-	160	8
Westmount	52	41	36	-	128	2
Bishopgate/Ranchdale	49	43	49	-	114	0
Dundurn Castle	57	49	44	-	121	2
Centennial Pkwy./ Violet Drive	55	58	60	-	160	2
Woodward/Brampton	51	76	66	-	184	14

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

	Criterion: 2.0(24 Hours) CADMIUM			CHROMIUM			IRON			Criterion: 5.0(24 Hours) LEAD			MANGANESE		
Station and Year	# of Samples	Geo. Mean	Max	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.	# of Samples	Geo. Mean	Max.
29001															
1978	25	.001	.004	25	.008	.042	25	1.6	9.0	25	0.5	2.1	25	.09	.52
1979	48	.001	.009	48	.007	.059	48	1.9	19.7	48	0.5	1.8	48	.10	1.08
1980	58	.001	.009	58	.003	.052	58	1.4	10.9	58	0.4	1.7	58	.08	3.24
1981	59	.001	.006	59	.005	.140	59	1.5	21.6	59	0.4	1.2	57	.07	.86
29008															
1978	23	.002	.007	23	.025	.130	23	4.1	31.4	321	0.8	7.5	23	.26	1.66
1979	215	.000	.004	189	.012	.064	207	3.9	24.7	311	0.7	3.0	207	.23	1.39
1980	313	.001	.018	345	.011	.089	343	4.3	35.3	347	0.6	1.9	346	.29	2.32
1981	324	.001	.009	323	.008	.097	324	2.8	22.3	326	0.6	2.3	325	.17	1.50
29011															
1978	9	.005	.008	9	.073	.091	9	19.9	27.5	9	0.8	1.1	9	1.17	1.56
1979	33	.002	.021	33	.022	.092	33	5.4	30.8	33	0.6	2.2	33	.39	1.72
1980	57	.001	.012	57	.025	.080	57	5.5	30.6	57	0.6	1.8	57	.47	1.58
1981	69	.002	.011	69	.021	.420	69	4.5	31.2	69	0.4	1.3	69	.32	1.85
29012															
1978	23	.002	.006	23	.015	.041	23	2.1	7.8	24	0.4	1.0	23	.11	.54
1979	43	.001	.003	43	.005	.030	43	1.6	7.8	43	0.3	0.9	44	.11	.54
1980	54	.001	.005	54	.007	.044	54	2.0	10.1	54	0.3	0.7	54	.15	.79
1981	68	.001	.007	68	.006	.030	68	1.4	8.7	68	0.2	0.9	68	.11	.67

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station Year	CADMIUM (Criterion: 2.0(24 Hours)) # of Samples	Geo. Mean	Max	CHROMIUM # of Samples	Geo. Mean	Max.	IRON # of Samples	Geo. Mean	Max.	LEAD (Criterion: 5.0(24 Hours)) # of Samples	Geo. Mean	Max.	MANGANESE # of Samples	Geo. Mean	Max.
29017															
1978	22	.002	.010	24	.015	.082	22	1.1	13.2	57	0.4	1.9	22	.09	.99
1979	58	.001	.007	58	.004	.066	58	2.3	19.7	58	0.4	2.7	57	.11	1.52
1980	55	.001	.005	55	.006	.057	55	2.2	9.6	55	0.3	1.5	55	.10	1.84
1981	57	.001	.007	57	.005	.086	57	1.9	28.1	57	0.3	2.6	57	.09	2.05
29025															
1978	23	.002	.012	24	.017	.094	23	2.9	18.1	301	0.9	3.3	23	.16	1.23
1979	181	.001	.039	182	.009	.208	190	2.9	33.7	309	0.6	4.2	181	.18	2.67
1980	327	.001	.032	304	.009	.169	291	2.6	17.2	328	0.5	1.9	327	.18	9.77
1981	317	.001	.023	317	.009	.103	317	2.3	32.9	317	0.6	3.1	316	.15	1.62
29067															
1978	40	.001	.005	39	.012	.040	39	2.8	15.4	39	0.5	1.0	39	.14	.60
1979	56	.001	.007	49	.008	.046	56	1.7	8.6	57	0.3	1.2	56	.11	1.07
1980	55	.001	.038	55	.007	.054	55	1.8	14.8	55	0.3	1.2	55	.14	1.43
1981	58	.001	.008	58	.006	.040	58	2.0	9.7	58	0.3	1.5	58	.08	.85
29085															
1979	30	.001	.003	30	.003	.071	30	1.3	8.7	30	0.3	0.9	30	.06	.46
1980	57	.001	.006	59	.003	.109	59	1.1	12.6	59	0.3	0.9	59	.05	.75
1981	55	.001	.004	54	.003	.057	55	1.2	14.6	55	0.3	1.3	54	.07	1.01

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Criterion: 2.0(24 Hours)   Criterion: 2.0(24 hours)

Station and Year	NICKEL # of Samples	NICKEL Geo. Mean	NICKEL Max	VANADIUM # of Samples	VANADIUM Geo. Mean	VANADIUM Max.	NITRATE # of Samples	NITRATE Geo. Mean	NITRATE Max.	SULPHATE # of Samples	SULPHATE Geo. Mean	SULPHATE Max.
29001												
1978	25	.009	.056	25	.00	.19	58	3.6	31.3	58	9.5	39.2
1979	48	.007	.040	48	.01	.08	57	4.7	19.8	57	11.9	27.6
1980	58	.004	.036	58	.01	.04	43	3.6	9.9	43	10.3	23.5
1981	59	.002	.038	59	.01	.05	59	4.1	15.2	59	9.1	24.2
29008												
1978	23	.007	.279	23	.00	.09	310	4.7	36.7	310	13.0	75.1
1979	207	.007	.069	207	.01	.04	239	4.0	21.7	240	13.6	49.9
1980	311	.006	.048	342	.01	.04	343	4.0	20.9	343	14.5	43.1
1981	325	.005	.048	325	.01	.05	326	3.6	20.8	326	10.8	43.6
29011												
1978	9	.031	.048	9	.01	.18						
1979	33	.007	.061	33	.01	.06	58	3.7	13.8	58	14.0	30.9
1980	57	.011	.030	57	.01	.04	56	4.1	12.7	56	14.9	33.0
1981	69	.007	.028	69	.01	.05	69	3.8	14.1	69	11.5	34.1
29012												
1978	23	.013	.036	23	.00	.01	53	3.9	13.5	53	10.3	37.0
1979	43	.005	.041	43	.00	.08	54	4.4	23.4	54	11.3	32.4
1980	57	.004	.032	54	.01	.06	52	3.6	13.7	51	10.9	22.2
1981	68	.003	.026	68	.01	.03	68	3.3	18.8	68	8.7	26.4

TABLE 2c CONSTITUENTS IN SUSPENDED PARTICULATE (ug/m^3)

Station and Year	NICKEL Criterion: 2.0(24 Hours) # of Samples	Geo. Mean	Max	VANADIUM Criterion: 2.0(24 hours) # of Samples	Geo. Mean	Max.	NITRATE # of Samples	Geo. Mean	Max.	SULPHATE # of Samples	Geo. Mean	Max.
29017												
1978	22	.019	.069	24	.00	.12	57	3.9	12.7	57	11.4	36.4
1979	58	.006	.078	58	.01	.13	49	4.2	23.6	49	12.1	34.5
1980	55	.007	.045	55	.01	.13	55	3.7	15.6	55	12.0	24.3
1981	57	.004	.055	57	.01	.08	57	4.0	17.9	57	10.3	28.6
29025												
1978	23	.005	.032	24	.00	.02	231	4.1	37.2	231	12.0	62.2
1979	181	.010	.164	181	.01	.09	281	4.0	25.0	281	13.6	40.4
1980	327	.010	.233	329	.01	.07	305	3.8	16.3	328	12.5	43.1
1981	317	.006	.051	317	.01	.08	317	3.3	25.0	317	9.5	41.0
29067												
1978	39	.010	.025	29	.00	.04						
1979	40	.005	.077	56	.00	.02						
1980	55	.007	.031	55	.01	.03						
1981	58	.002	.053	58	.01	.03						
29085												
1979	30	.003	.017	28	.00	.02	21	3.9	14.2	21	10.5	18.5
1980	59	.003	.022	59	.01	.03	59	3.5	12.4	59	10.7	20.7
1981	55	.001	.023	53	.01	.03	55	3.7	14.2	55	9.3	27.6
29087												
1979							21	4.0	12.5	21	11.9	24.1
1980							58	3.4	9.7	58	11.2	27.0
1981							58	3.3	11.9	58	9.2	24.4

TABLE 2d

COMPARISON OF SUSPENDED PARTICULATES DURING

AUG - NOV. STELCO STRIKE PERIOD AND REMAINING 8 MONTHS

Geometric Means - ug/m^3

Station	Aug. - Nov. 1980	Aug. - Nov. 1981 Strike	Other 8 Months 1980	Other 8 Months 1981
29001	56^{20}	48^{20}	81^{38}	73^{39}
29007	45^{20}	48^{19}	68^{38}	62^{37}
29008	86^{113}	49^{108}	100^{229}	87^{219}
29009	41^{20}	56^{29}	86^{39}	68^{39}
29011	97^{20}	74^{30}	142^{37}	117^{39}
29012	59^{19}	53^{28}	82^{35}	69^{40}
29017	71^{21}	64^{19}	93^{34}	81^{38}
29025	76^{111}	65^{108}	95^{217}	76^{209}
29067	50^{30}	46^{18}	75^{37}	61^{39}
29085	42^{20}	50^{20}	65^{39}	58^{35}
29087	52^{21}	62^{20}	74^{37}	65^{38}
Avg.	61	56	87	74

Exponents indicate number of samples

TABLE 3a

SOILING INDEX - 1981

1-HOUR TELEMETERED INSTRUMENTS

UNITS - COH's per 1000 linear ft. of air

Ontario Objectives - 24-hour - 1.0
1-year - 0.5

	Annual Average 1981	1980	1979	1978	Maximum 24-hour	No. of Times Above Objective 24-hour
29008 - North Park	.72	.72	.73	.67	1.8	76
29025 - Barton/Sanford	.58	.54	.63	.56	1.8	24

1-hour telemetered data not directly comparable to 2-hour data - see text

TABLE 3b

SOILING INDEX - 1981

2-HOUR INSTRUMENTS

UNITS - COH's per 1000 linear feet of air

Ontario Objectives - 24-hour - 1.0
1-year - 0.5

	Annual Average 1981	1980	1979	1978	Maximum 24-Hour	No. of Times Above Objective 24-Hour
29001 - Hughson/Hunter	.28	.23	.32	.25	1.2	1
29009 - Kenilworth	.22	.19	.18	.15	0.9	0
29011 - Burlington/Leeds	.31	-	-	-	1.3	1
29012 - Burlington/ Wellington	.23	.20	.18	.16	0.9	0
29015 - Merrick/James	.25	.24	.28	.28	0.8	0
29017 - Chatham/Frid	.28	.22	.29	.25	1.1	1
29067 - 450 Hughson N.	.22	.20	.24	.23	0.7	0

2-hour data not directly comparable to 1-hour telemetry data - see text

TABLE 4

DUSTFALL 1981

UNITS - GRAMS/SQ. METRE/30 DAYS

Ontario Objectives - 1 month avg - 7.0
1 year avg - 4.5

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average 1981	Average 1980	Average 1979
29001 Hughson/Hunter	3.6	6.8	7.1	6.9	8.4	26.8	5.6	9.2	6.9	3.7	3.1	-	8.0[11]	6.5	7.5
29006 Queenston	4.5	8.4	8.1	5.6	5.7	8.0	13.0	6.3	6.5	2.7	3.8	5.9	6.6	6.4	6.2
29008 North Park	20.7	20.6	17.2	10.5	13.5	17.5	11.3	8.3	9.8	6.4	5.8	12.4	12.8	13.9	13.8
29009 Kenilworth	3.9	5.8	7.0	5.3	7.0	5.9	5.8	6.9	8.8	2.3	4.0	3.7	5.5	5.1	5.9
29010 Burlington/Ottawa	9.1	31.1	17.0	18.4	26.3	25.9	28.7	33.0	31.9	33.5	30.2	26.1	25.9	19.5[11]	17.4[4]
29011 Burlington/Leeds	7.2	13.7	16.3	14.6	23.6	17.6	16.4	12.1	11.2	8.9	7.4	9.7	13.2	14.8[11]	16.3
29012 Burlington/ Wellington	5.2	8.6	9.3	9.4	11.0	11.4	11.1	8.5	8.7	4.7	4.3	9.8	8.5	9.5	8.8[10]
29017 Chatham/Frid	4.5	11.3	21.1	10.0	10.5	14.1	-	35.1	6.1	2.2	4.1	3.3	11.1[11]	10.6	9.5
29019 Mohawk/Warren	2.7	3.5	3.6	4.2	4.3	5.0	3.6	6.6	5.0	2.4	1.9	2.4	3.8	3.5	4.5
29025 Barton/Sanford	4.4	10.1	6.6	8.5	13.3	11.6	8.3	14.0	8.8	7.3	6.2	5.3	8.7	9.0	10.7[10]
29026 Woodward/Brampton	4.2	5.0	7.0	6.4	5.8	7.3	9.9	4.1	11.0	9.7	7.1	8.4	7.2	5.8	5.3
29030 Camden/Mohawk	2.9	7.9	6.3	6.2	5.0	7.9	7.9	7.6	8.0	2.4	2.4	4.5	5.8	5.7	5.0
29031 Concession/ Upper Sherman	4.6	7.6	8.7	6.0	8.7	8.9	8.4	7.6	8.1	4.6	4.1	5.3	6.9	6.3	8.0

- Underlined values are above objective

TABLE 4 (Cont'd)

DUSTFALL 1981

UNITS - GRAMS/SQ. METRE/30 DAYS

Ontario Objectives - 1 month avg - 7.0
1 year avg - 4.5

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average 1981	Average 1980	Average 1979
29036 Roosevelt/Beach Rd.	6.6	10.7	9.3	8.6	13.7	11.0	11.7	11.7	11.0	16.6	-	18.9	11.8[11]	10.9	14.7
29037 Strathearn	11.9	19.9	14.9	22.3	25.5	34.4	13.8	18.9	23.4	36.1	19.0	15.8	21.3	21.1	24.8
29044 Wark/Beach Blvd.	7.7	10.2	7.6	9.0	8.0	10.9	9.6	8.9	9.2	8.9	1.4	7.1	8.2	9.6	11.7
29046 O.P.P. Bldg Burlington	2.9	3.8	3.5	3.4	1.1	-	5.7	3.3	3.2	1.8	1.7	3.1	3.0[11]	4.2	4.8
29067 450 Hughson N.	5.3	6.1	4.3	6.3	9.7	7.5	4.5	11.2	4.5	2.6	5.7	4.1	6.0	5.9	6.1
29082 Leaside Rd.	8.0	6.4	7.3	9.3	7.4	15.2	17.5	13.5	10.7	7.2	-	5.3	9.8[11]	7.2	8.5
29084 Rembe/Beach Blvd.	-	9.4	5.7	5.9	6.7	-	20.0	8.3	7.3	10.1	3.4	4.6	8.1[10]	7.4[11]	6.4[11]

- Underlined values are above objective

TABLE 5

SULPHUR DIOXIDE

UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .25
24-hour - .10
1-year - .02

		Annual Average	Maximum		No. of Times Above Objective	
			1-hour	24-hour	1-hour	24-hour
29008 - North Park	1981	.014	.12	.07	0	0
	1980	.014	.13	.07	0	0
	1979	.012	.14	.08	0	0
	1978	.013	.13	.07	0	0
29025 - Barton/ Sanford	1981	.010	.14	.06	0	0
	1980	.013	.16	.06	0	0
	1979	.017	.25	.10	0	0
	1978	.016	.29	.07	1	0

TABLE 6

TOTAL REDUCED SULPHUR

UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 20 (Hydrogen Sulphide)

		Annual Average	Maximum	No. of Times Above Objective
29008 - North Park	1981	1.6	47	35
	1980	1.8	44	26
	1979	1.6	32	3
	1978	1.2	36	5
29025 - Barton/ Sanford	1981	1.3	83	46
	1980	0.9	61	26
	1979	2.4	144	75
	1978	1.6	66	74

TABLE 7

CARBON MONOXIDE

UNITS - PARTS PER MILLION

Ontario Objective: 1-hour - 30
8-hour - 13

		Annual Average	Maximum 1-hour	Maximum 8-hour	No. of Times Above Objective 1-hour	No. of Times Above Objective 8-hour
29025 - Barton/Sanford	1981	1.2	15	8	0	0
	1980	0.9	10	4	0	0
	1979	1.5	14	9	0	0
	1978	1.2	9	5	0	0

TABLE 8

NITROGEN DIOXIDE

UNITS - PARTS PER MILLION

Ontario Objectives: 1-hour - .20
24-hour - .10

		Annual Average	Maximum 1-hour	Maximum 24-hour	No. of Times Above Objective 1-hour	No. of Times Above Objective 24-hour
29008 - North Park	1981	.027	.24	.08	3	0
	1980	.028	.15	.10	0	0
	1979	.034	.16	.10	0	0
	1978	.040	.14	.11	0	1
29025 Barton/Sanford	1981	.029	.15	.08	0	0
	1980	.027	.15	.06	0	0
	1979	.029	.12	.07	0	0
	1978	.046	.18	.12	0	3

TABLE 9

NITRIC OXIDE

UNITS - PARTS PER MILLION

		Annual Average	Maximum 1-hour	Maximum 24-hour
29008 - North Park	1981	.061	.67	.27
	1980	.065	.52	.16
	1979	.068	1.00	.23
	1978	.069	.69	.24
29025 - Barton/Sanford	1981	.024	.83	.29
	1980	.021	.43	.13
	1979	.030	.78	.43
	1978	.026	.60	.15

TABLE 10

NITROGEN OXIDES
(Sum of Nitrogen Dioxide and Nitric Oxide)

UNITS - PARTS PER MILLION

		Annual Average	Maximum 1-hour	Maximum 24-hour
29008 - North Park	1981	.087	.73	.32
	1980	.093	.55	.21
	1979	.101	1.04	.30
	1978	.110	.76	.30
29025 - Barton/Sanford	1981	.054	.95	.37
	1980	.046[10]	.34	.12
	1979	.059	.88	.50
	1978	.073	.64	.22

TABLE 11

OZONE

UNITS - PARTS PER BILLION

Ontario Objective: 1-hour - 80

		Annual Average	Maximum	No. of Times Above Objective
29025 - Barton/Sanford	1981	16.3	89	15
	1980	17.4	107	24
	1979	15.3	112	32
	1978	16.3	119	71

TABLE 12

FLUORIDATION RATE - 1981

ALL VALUES IN MICROGRAMS/100 SQ.CM/30 DAYS

Ontario Criteria: April 15 to October 15 - 40
October 16 to April 14 - 80

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average 1981	Average 1980	Average 1979
29001 Hughson/Hunter	20	29	24	26	54	35	24	26	18	22	69	-	32[11]	31[11]	43
29008 North Park	121	146	101	106	56	106	50	33	45	29	36	78	76	99	76
29012 Burlington/ Wellington	26	24	18	32	46	33	30	25	23	20	28	32	28	35[11]	37[10]
29017 Chatham/Frid	36	35	35	49	72	66	29	98	33	24	37	30	45	38	49
29025 Barton/Sanford	26	28	31	39	52	51	37	33	23	22	30	24	33	35	60
29026 Woodward/Brampton	33	37	39	45	31	51	33	30	23	19	33	31	34	33	46
29054 Beach Rd./Conrad	46	86	101	71	58	63	121	48	54	47	37	71	67	55	71
29058 Q.E.W./Skyway	138	193	137	93	117	155	101	53	54	54	92	127	110	135	131
29059 Burlington/Gage	80	126	89	98	194	86	86	69	48	73	65	64	90	103	93
29062 Briarwood School King St. E.	75	98	101	76	78	109	50	57	59	60	117	47	77	60	71[10]
29066 Killarney/Beach B.	89	108	77	78	46	51	34	28	29	26	36	64	56	70	68

- Underlined values are above objective